Influence of Global Change on Regional Air Quality in the Pacific Northwest and Northern Midwest Regions

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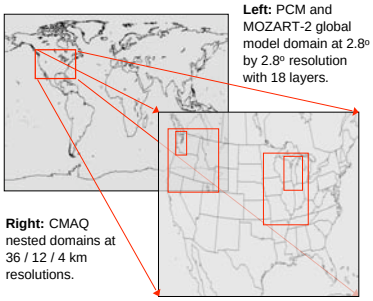
Introduction

Global warming, population growth, and land use changes are closely interrelated forces that may cause significant changes in future air quality. To address this issue, we are employing a comprehensive modeling approach to assess the probable effects of global climate change on regional air quality in the Pacific Northwest and Northern Midwest regions.

Modeling System

GLOBAL MODELS
- NCAR/DOE Parallel Climate Mode (**PCM**) for global meteorology
- NCAR Model for Ozone and Related Chemical Tracers (**MOZART**) Global Chemical Transport Model

REGIONAL MODELS
- **MM5** NCAR Mesoscale Meteorological Model v3.6.2
- **SMOKE** UNC Emissions Processing System v2.1
- **CMAQ** EPA Multi-scale Air Quality Model v4.4



Left: PCM and MOZART-2 global model domain at 2.8º by 2.8º resolution with 18 layers.

Right: CMAQ nested domains at 36 / 12 / 4 km resolutions.

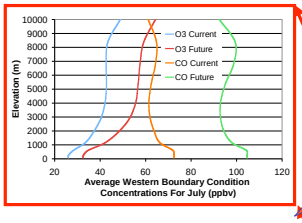
PCM-MOZART Output

Using PCM meteorology, MOZART outputs 3-hour gridded concentrations for input into the CMAQ regional model. MOZART simulations capture the long range transport critical for assessing the impact of Asian pollution on regional air quality.

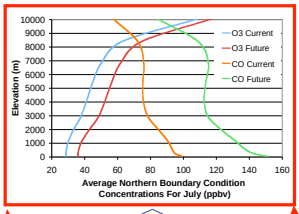
Boundary Conditions

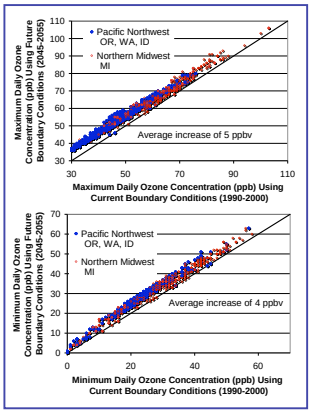
Global MOZART output are processed for input as boundary conditions into the 36 km CMAQ regional model. To quantify the sensitivity of the regional model to global model output, the western and northern boundary conditions were analyzed for the month of July. The Figures to the right compare the average O_3 and CO vertical boundary condition profiles for the current and future decade simulations.

Below: Average western boundary conditions (from MOZART) for O_3 & CO increased by ~11 & 32 ppbV, respectively, between the base case and future scenarios.

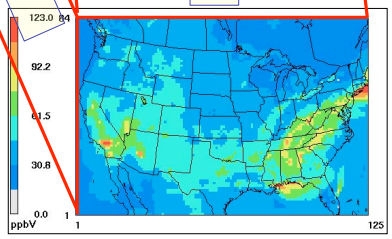


Below: Average Northern boundary conditions (from MOZART) for O_3 & CO increased by ~10 & 40 ppbV, respectively, between the base case and future scenarios.





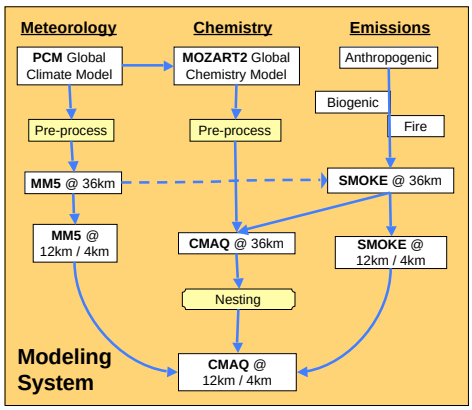
Left: Using current meteorology and emissions for July 1990, CMAQ simulations show peak daily O_3 concentrations in the PNW & NMW regions increase by ~5 ppbV as a result of changes in boundary conditions from the current to future periods. Similarly, minimum daily O_3 concentrations increase by ~ 4 ppbV in the two regions.



Above: Preliminary CMAQ O_3 mixing ratios for the base case simulation (1990-2000).

Modeling Approach

- GLOBAL: PCM and MOZART
  - Compare current decade (1990-2000) to future decade (2045-2055) using IPCC A2 scenario
  - Decade long simulations are necessary to account for inter-annual climate variability
- REGIONAL: MM5 / SMOKE / CMAQ
  - 36 km continental US long term simulations (10 years)
  - 12 km Pacific Northwest and Northern Midwest simulations (selected months)
  - 4 km urban centers (selected short episodes)
- Additional sensitivity analysis
  - Changes to projected anthropogenic emissions
  - Changes in future fire emissions due to land management practices
  - Changes to future biogenic emissions in response to variations in vegetation/land use



Regional CMAQ Results

Preliminary analysis shows that average ozone concentration in the CMAQ boundary conditions, for the month of July, increase by approximately 10 ppbV between the current (1990-2000) and future (2045-2055) decades. This change in boundary conditions results in an increase of approximately 5 ppbV in the average and peak surface ozone concentration when meteorology and emissions are held constant.

Ongoing Research

The base case CMAQ simulation is underway.
MM5 simulations of current meteorology are almost complete.
Prototype fire scenario builder is complete and being tested.

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